Notes on Celery Blight.

Flora W. Patterson

C. O. Townsend

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THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

Bulletin No. 74. May, 1901.

NOTES ON CELERY BLIGHT.

C. O. Townsend.

INTRODUCTION.

The diseases of celery have been a matter of observation and study at the Maryland Experiment Station and throughout the state during the past three years, and it can be stated with certainty that the greatest hindrance to successful celery culture in Maryland has been and is at present the disease known as Early Blight or Rust. It is equally certain that this disease may be overcome at a trifling expense by the application of suitable remedies at the proper time. Many failures in celery growing may be traced directly to the blight simply because the plants were not treated or because they were not properly treated with the right fungicide at sufficiently frequent intervals. It is not to be understood, however, that fungicides alone will produce good celery; proper attention must be given to the nature of the soil, to the food and water supply of the plants, to cultivation, and to the other horticultural questions that are of prime importance in celery growing; but given the proper conditions and the proper care, celery of the finest quality may be produced in many parts of Maryland where it is at present a total stranger in both gardens and fields.

CAUSE AND EFFECT OF CELERY BLIGHT.

Celery blight is due directly to the influence of a delicate thread-like fungus called Cercospora Apii, which grows into the tissues of the celery leaves and causes them to turn brown and to lose their proper functions. This fungus, like all fungi of this class, is reproduced by minute bodies called spores, which are light and easily carried by the wind through long distances and which are able to retain their vitality for an indefinite period. These minute bodies lodge upon the leaves of the celery and under suitable conditions produce the thread-like parts of the fungus that penetrate the surfaces of the leaves and bring about the diseased condition of the plants. The most favorable condition for the development of this fungus is a period of drought accompanied by considerable heat and followed by damp weather. It has been observed repeatedly that when these conditions prevail a serious outbreak of the blight follows, and the destruction is more rapid and more general than when the weather continues moderately dry or moderately moist. When the fungus has penetrated the leaf it increases rapidly, and causes the infested spots to turn brown. The number of these brown or diseased spots upon a leaf varies from one to several, and they increase in size until eventually the whole leaf becomes

discolored and dies. The spots are light at first but are not conspicuousuntil they turn brown. The outer and older leaves are at first attacked and the disease usually spreads toward the centre of the plant. If the conditions for the development of the fungus are favorable the disease spreads rapidly toward the centre of the plant causing the entire plant to be destroyed,but if the conditions for the development of the fungus are less favorable, the disease works less rapidly and the plant continues to struggle on sometimes through the entire season. It not unfrequently happens that only the outer leaves are seriously diseased,thus leaving the central part nearly free from blight. It is not uncommon to find plants in all stages of injury from blight in the same field, as a vigorous, thrifty, rapidly growing plant will be less liable to severe injury than a weak, stunted plant, since the former is able to outgrow in a measure the effects of the fungus. It is important, therefore, that healthy settings be secured and that they be given every possible advantage for rapid growth and development. It often happens that the fungus attacks the plants while they are still in the seed bed, and for this reason any treatment that the plants are to receive for the prevention of the blight should be begun before the seedlings are transplanted. Here, as in almost all fungous diseases, the highest degree of success depends upon preventing the fungus from attacking the host plants, since it is impossible to destroy the fungus without injuring the plant after the fungus has entered the leaf.

OBSERVATIONS IN 1898.

The immediate cause that led to the study of celery blight at this time was the apparent inability of the remedies suggested to control this disease, combined with the possibilities of celery growing in Maryland, provided the blight could be overcome with comparative ease and at small expense. During the summer of 1898 a number of celery growers sent to the Experiment Station diseased celery plants or leaves with the request that the cause of the trouble and a proper remedy for the same be furnished. The disease in each case proved to be blight,and with the nature of the fungus in mind,minute directions were given for the preparation and application of suitable fungicides. The directions given were followed by the growers,but in spite of the treatment the plants continued to die,and at the end of the season an almost total failure was reported in nearly all cases. In examining into the cause of the failure of the remedy suggested several questions presented themselves, viz: Was the fungicide used (Bordeaux mixture) the best fungicide for the control of this disease? Are our climatic conditions such that no fungicide will control the disease? Were the applications of the fungicide not sufficiently frequent to keep the fungus in subjection?

The Bordeaux mixture used was made up in the proportion of six pounds of blue stone and six pounds of lime in fifty gallons of water and was prepared in accordance with the usual method of making this mixture. Several applications were made at intervals of from one to two weeks beginning in the latter part of August, too late to have the desired effect, in addition to which the weather was most favorable for the development of the fungus since it was extremely dry during the greater part of August,

followed by frequent showers that kept the soil as well as the atmosphere in a moist condition for several days. In order to answer the foregoing questions and thereby to arrive at proper conclusions in regard to the treatment of celery blight and to convince our growers that celery practically free from disease may be grown in this state, it was decided to carry through a series of tests. Accordingly the following experiments were planned and carried out in 1899 and 1900.

EXPERIMENTS IN 1899.

While weather conditions are important factors in producing celery blight as well as all other fungous diseases, it is true that no fungus disease will be produced unless the spores of the particular fungus that produce the disease in question are in contact with the plant and capable of germinating. Hence if the spores of the blight-producing fungus can be kept away from the plants or kept from germinating, the blight will not be produced whatever the weather conditions may be. In combating this disease, therefore, it is necessary either to produce those conditions under which the spores of the fungus cannot come into contact with the celery leaves, or to bring about those conditions under which the spores are unable to germinate. In order to determine which method of procedure would be best and for the purpose of finding a satisfactory remedy for celery blight the following experiments were undertaken. A part of one of the beds of late celery on the College grounds was divided into four plats of equal size, each plat containing about one hundred and fifty plants. The several plats were treated as follows: No. 1 was shaded, No. 2 was sprayed with ammoniacal carbonate of copper, No. 3 was sprayed with Bordeaux mixture and No. 4 was left untreated for comparison. We will now consider the methods of treatment and the results in each case.

Shading.—In shading plat No. 1 a framework 18 inches high was built over the plat, (one end of which is shown in Fig. 1) and over the frame work was spread a single thickness of muslin. The shading was begun about the middle of July, as soon as the plants were placed in the beds, and was continued throughout the entire hot season of July and August. Early in September the weather turned cooler and the shading was then discontinued, since it has been learned that the celery blight fungus will not thrive in cool weather. Just how far the shading prevents the fungus from growing or renders the celery plants more vigorous and resistent it is difficult to determine. It is entirely possible that the beneficial results of shading were due in a large degree to the fact that the roots of the celery were thereby kept in a cooler condition, thus enabling the celery plants to outgrow in a measure the injurious influence of the fungus.

Ammoniacal Carbonate of Copper.—The ammoniacal carbonate of copper used on plat No. 2 was prepared by placing one ounce of copper carbonate in just enough ammonia water to dissolve it and then diluting to nine gallons with ordinary water from the well or hydrant. The amount of ammonia water required to dissolve an ounce of copper carbonate is about one-half pint and this should be diluted from one and one-half to two quarts of water before the carbonate is placed in it. It should be stated in this connection that the strength of commercial ammonia

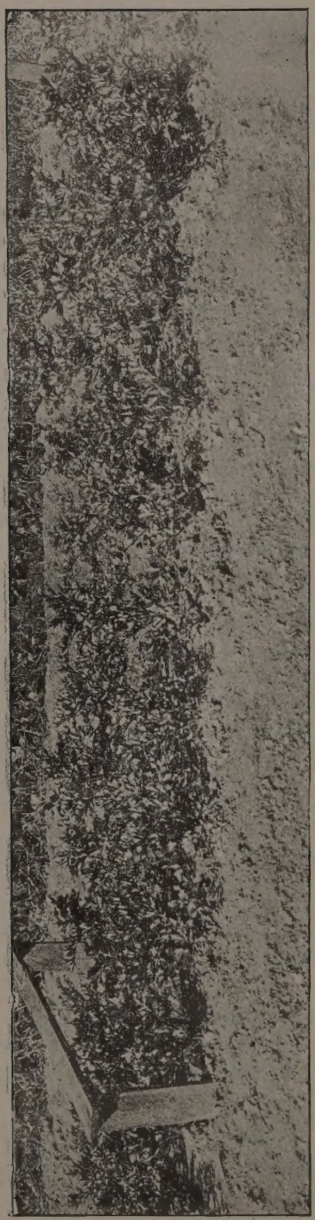

FIG. I.—Celery shaded with muslin.

FIG. II.—Celery sprayed with Ammoniacal Carbonate of Copper.

water is so variable that it is impossible to tell just how much will be required to dissolve a given quantity of copper carbonate. But in no case should there be an excess of ammonia since if there is it is liable to burn the foliage. If a large amount of this fungicide is required, either for immediate use or for numerous sprayings at intervals of several days for a period of two or three months, it is much more convenient to prepare a so-called stock solution. This is done by dissolving a comparatively large quantity of copper carbonate in just enough dilute ammonia water to dissolve it. This solution should be so prepared that a known quantity of the copper carbonate is dissolved in a given amount of the liquid, so that in removing a given quantity of the solution we get a definite quantity of copper carbonate, i. e. if ten ounces of copper carbonate were dissolved in ten pints of the liquid, it would be necessary to remove only one pint of the solution and to dilute it to nine gallons in order to get a properly prepared fungicide of the desired strength. The stock solution should be kept in a closely stoppered bottle otherwise it will lose its strength, but in this condition it will keep for several weeks. In addition to the convenience of the stock solution, it is much safer than to prepare the fungicide fresh each time. When the stock solution is once properly made the fungicide may be prepared from it without any danger of injuring the foliage upon which it is used, whereas each time a new solution is made from the original material there is more or less danger of having an excess of ammonia and thereby injuring the foliage when used. In the experiments under consideration, a stock solution of ammoniacal carbonate of copper was prepared and the plants in plat No. 2 were sprayed thoroughly at intervals of from two to four days only, beginning about the middle of July and continuing until the middle of September, when the weather turned cooler. The object in spraying so often was to determine whether or not there was any virtue in this fungicide in preventing celery blight, and not for the purpose of determining how many sprayings would hold this disease in check. In spraying a plant like celery where new leaves are constantly appearing, it is necessary that the spraying should be frequent in order to keep the fungus from getting a foothold on the new growths. At the time the spraying was begun, the outer leaves were already affected by the disease, and as was expected, the fungicide did not restore the diseased leaves, nor did it prevent the disease from progressing in those leaves. On the other hand, however, the central leaves that were healthy or that were developed after the spraying was begun remained almost entirely free from disease and made a good growth as shown in Fig. II. When this plat is compared with plat four as shown in Fig. IV, the benefits of spraying may be easily recognized.

Bordeaux Mixture.—Plat No. 3 was sprayed with Bordeaux mixture which was prepared by dissolving one-half pound of blue-stone in two gallons of water, and slaking one-half pound of good stone lime in two gallons of water, then pouring the two solutions together and stirring them thoroughly. This solution should be applied as soon as possible after it is prepared since it loses its virtue after a few hours. In this as in the preceding

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Note.—**It has been considered advisable to give the methods used in preparing the fungicides, since some growers who are combating this disease are in doubt in regard to the proper methods of preparing and applying the solutions.**

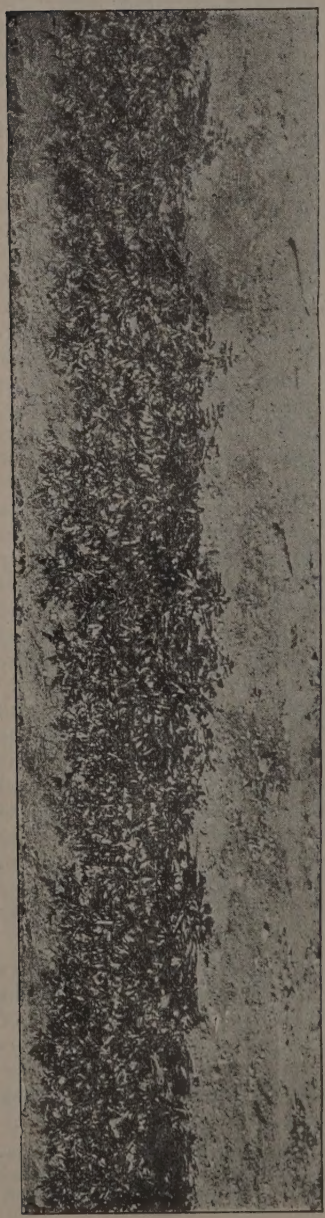

FIG. III.—Celery sprayed with Bordeaux mixture.

FIG. IV.—Celery not treated, for comparison.

case it is most convenient to prepare stock solutions provided a large amount of spraying is to be done, or if frequent sprayings of even small areas extending over a period of several weeks are to be carried on. It is most convenient to prepare stock solutions by dissolving a given number of pounds of blue-stone in the same number of gallons of water, slaking a given number of pounds of good stone lime, and then adding the same number of gallons of water as there were pounds of lime; for example, we usually dissolve fifty pounds of blue-stone in fifty gallons of water and slake fifty pounds of lime and dilute to fifty gallons with water. The blue-stone is most quickly dissolved by placing it in a coarse sack and suspending it near the top of a barrel filled with water. In preparing the lime solution, the lumps of lime should be placed in the bottom of the barrel and just enough water added to slake it thoroughly, after which the required amount of water should be added. The stock solution prepared in this manner will keep for several weeks, and from them the Bordeaux mixture may be quickly and easily prepared when wanted. Before using the stock solutions for the purpose of making Bordeaux mixture they should be thoroughly stirred, then one gallon of either solution will contain one pound of the solid from which the solution was prepared. If only one gallon of Bordeaux mixture is desired take one pint of the blue stone solution and dilute to two quarts; one pint of lime solution and dilute to two quarts, then pour the two solutions together and stir vigorously. In the same manner any amount of Bordeaux mixture may be prepared simply by keeping the same proportion of bluestone, lime and water. In the experiment under consideration the sprayings were begun about the middle of July at which time the blight was plainly visible on all the older leaves, and it was not to be expected that the spraying would save them. However, the fact that the disease was so thoroughly established furnished the best possible opportunity for testing the value of Bordeaux mixture in preventing the disease from attacking the leaves that were still healthy. With this object in view and not for the purpose of determining how few sprayings would be necessary, plat No. 3 was sprayed several times each week up to the nineteenth of September, at which time the weather turned cooler and further sprayings were not necessary. As was expected all the leaves that were diseased when the spraying began became gradually worse and finally died. On the other hand, the leaves that were healthy as well as the leaves that came out after the spraying began remained free from disease throughout the season and made a good growth as shown in Fig. III. The plants were not quite as large as in plat 2 where ammoniacal carbonate of copper was used,and it is the general opinion that Bordeaux mixture has a tendency to retard the growth of celery. However, the results were found very satisfactory when plat 3, shown in Fig. III. was compared with the control plat represented in Fig. IV. The cuts of the respective plats were taken from photographs made at the end of the season, Nov. 15th. Bordeaux mixture has a tendency to stick to the celery, and while this quality renders it a good fungicide, it is liable to injure the sale of the plants, if the spraying has to be carried on too near to the harvesting season. This objection may be overcome, if it is desirable to use the Bordeaux mixture, by doing the later sprayings with a colorless fungicide like the ammoniacal carbonate of copper. This makes it necessary to prepare two fungicides

and as already shown ammoniacal carbonate of copper may be used with satisfactory results throughout the season.

Control.—The plants in the untreated plat were of the same number and in the same condition as those in the other plats when the experiment was begun. They likewise received the same care and cultivation as the other plats with the exception that no effort was made to control the blight. As the season advanced the disease injured the plants to such an extent that about one-half of them died outright, and of the remaining half the plants were very small owing to the constant attack of the fungus and the consequent loss of leaves. See Fig. IV. and compare with Figs. I. II. and III. The disease advanced from the outer leaves that were first attacked toward the center of the plant so that each plant presented a struggle for existence. If the development of the celery plant was moderately slow, the disease spread to the central leaves and overcame them before they had time to develop, in this way destroying the entire plant. If the celery plant developed more rapidly, it kept ahead of the fungus and lived throughout the season, but in each and every case the plants were seriously injured. Hence the natural vigor and strength of the plant goes far toward resisting the ravages of the blight, but unless some means is used to overcome the fungus, even the strongest plant will be seriously affected and the weaker plants will be completely destroyed.

Results.—In summing up the results of the experiments for 1899, the fact stands out very distinctly that celery blight may be kept under complete control by the proper use of the right fungicides.

The best results were obtained with ammoniacal carbonate of copper. This fungicide not only kept all the healthy and new leaves free from the fungus, but the plants grew better than with any other treatment employed. Unfortunately the plats were disturbed just before the celery was dug so that no data of an accurate nature could be obtained except in a general way. The cuts taken from photographs show the general results in a fairly satisfactory manner.

Bordeaux mixture gave results that were in every way satisfactory except that the plants were somewhat retarded in their growth. This is, of course, a serious objection to the use of this fungicide, but it is not probable that the dwarfing of the plants would have been so great if the sprayings had been less frequent, and it is possible that the results in controlling the disease would have been just as satisfactory.

While shading is of considerable advantage to the plants, it does not prevent the attacks and development of the blight fungus. It is possible that a denser shade would have been more satisfactory but it is not probable that even this would have prevented the disease from attacking the plants to some extent. It is also an interesting question in this connection to know what results could be obtained by a combination of shading and spraying. From the fact that the shading is beneficial in keeping the plants and especially the roots cool and also that the fungicides are capable of keeping the plants free from blight, it would seem that a combination of these methods would give good results.

EXPERIMENTS IN 1900.

In order to reach more definite conclusions in regard to the treatment of celery blight, and for the purpose of obtaining still more exact information in regard to the results of the treatment, it was decided to carry similar experiments through the season of 1900 before reporting fully upon the subject. The plants for these experiments were selected with a view to their uniformity in size and healthfulness. They were planted in beds extending east and west, the rows running crosswise of the beds i. e. north and south, and consisting of ten plants each, set one foot apart. The celery being a late variety again, the plants were transplanted from the seed bed to the garden beds on July 25th, at which time it was noticed that the plants were slightly affected with the blight, proving that it would have been advisable to spray the plants in the seed bed before they were in any degree attacked by the disease. It is not probable that there is any danger of spraying too early and it is very important that the plant be kept free from the fungus, which can be done only by spraying the plants before they are attacked. Experience has shown that the leaves that are attacked cannot be saved and that we can hope to keep in a healthy condition only those leaves that are free from the fungus when the treatment is begun. The plats for these experiments were laid off from one of the beds as follows: No. 1 was shaded, No. 2 untreated for control, No. 3 sprayed with ammoniacal carbonate of copper, No. 4 untreated for control, No. 5 sprayed with Bordeaux mixture. Each plat consisted of ten rows of ten plants each, making one hundred plants in each plat. The soil was uniform in all of the plats and each plat received the same treatment in the way of cultivation and general care as the others, the only difference consisting in the treatment or non-treatment for the blight. No resetting was done in the place of plants that died from any cause; the plats were simply followed throughout the season, and the final results were obtained when the plants were dug.

Shading.—As soon as the plants were set in the bed the first ten rows were shaded in a similar manner as in the preceding year, except that a double layer of mosquito netting was used instead of muslin. Out of the one hundred plants in the plat only seventy-five survived throughout the season, and these were small, as will be seen by referring to the table on page 181. It must be remembered however that the plants were more or less seriously affected when they were set, hence just what effect the shading would have had on perfectly healthy plants, it is not possible to say. It is also true that the shading was very light and observation has shown

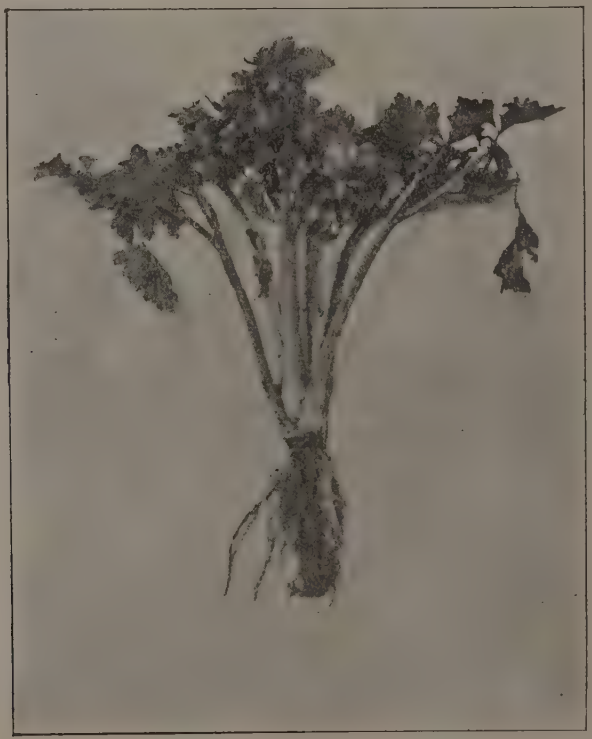

FIG. V.—An average plant from the shaded plat.

that the deeper the shading the better the results. However, it will be seen by referring to figures VII and VIII that the average plant in the shaded plat was equal to the best in the untreated plats; it is fair, therefore, to conclude that with deep shading the results would be much more satisfactory than no treatment, provided circumstances were such that other treatment than shading was impossible. In these as in the corresponding experiments of the previous year, everything indicates that very satisfactory results could be obtained by a combination of shading and spraying, since the shading not only retards the development of the fun-

gus but also provides more favorable conditions for the growth of the celery plants themselves.

Ammoniacal Carbonate of Copper.—Five days after the plants were in the beds they had entirely recovered from the effects of transplanting and the spraying was begun. It was our intention to use the same strength of the fungicide that was used the preceding year, but owing to the fact that the ammonia water was stronger than that previously used and the proper precaution was not taken in preparing the stock solution, an excess of ammonia was present which resulted in considerable damage to the plants at the first spraying. Many of the leaves were injured so that on

FIG. VI.—An average plant from the plat treated with ammoniacal carbonate of copper.

the following day evidences of the foliage having been scalded by an excess of ammonia were plainly visible, and as soon as this was discovered a new stock was properly made and used for all subsequent sprayings. While all leaves that were previously affected or that were injured by the first spraying eventually died, the fungicide kept all new and healthy plants free from the fungus throughout the season. The applications were made once each week until the middle of September, at which time

FIG. VII.—An average plant from the plat treated with Bordeaux mixture

the weather turned cooler and rendered further treatment unnecessary. Of the one hundred plants originally in this plat eighty-six survived throughout the season, but they never recovered from the injury produced by the first spraying, hence the results of this plat do not represent the effects of this fungicide under normal conditions; however, it serves to impress upon us the importance of having our fungicides properly made. It should be stated in this connection that the amount of ammonia water used in making ammoniacal carbonate of copper should be *just sufficient to dissolve the copper carbonate.* Figure 6 represents an average plant from the plat photographed at the digging time, Nov. 19, and the table on page 181 compares this plat with the other plats under consideration. If properly prepared, this fungicide is more satisfactory than Bordeaux mixture as shown by the previous year's experiments as well as by the experiences of others. The advantages of this fungicide over Bordeaux mixture have already been stated.

Bordeaux Mixture.—The first application of Bordeaux mixture was made on July 30th at which time the plants in this plat had entirely recovered from the effects of transplanting. The Bordeaux mixture used was prepared in the same manner as in the experiments of the preceding year, and the applications were made weekly until the cool weather appeared which was about the middle of September. The leaves that were diseased when the plants were transplanted from the seed bed died, but all other leaves remained healthy and made a good growth, as shown from Fig. 5 and also from the table on page 181. It should be stated that figures from V to IX inclusive were made from photographs taken at the time the celery was dug, and show the relative size of the plants from the several plats. Ninety-six of the one hundred plants in this plat survived the entire season and all were of marketable value. The four plants that died, dried up soon after they were set out but did not appear to be destroyed by the blight. In a commercial bed their places could easily have been filled by new plants, which, if properly sprayed, would have made a solid bed of marketable plants. One of the average plants is shown in Fig. VII.

Control Plats.—The plants in the two control plats averaged seventy-three plants in each plat, i. e. out of the original one-hundred plants, twenty seven died and the remaining seventy-three were small and many of them were absolutely worthless Fig. VIII shows one of the best of the control plants and figure IX shows one of the poorest. It is apparent that all these control plants were more or less seriously affected by the blight. In some instances the plants developed more rapidly than the blight and therefore made some growth in spite of the disease. In other cases the fungus developed most rapidly so that each new leaf as it appeared was soon affected, with the result that the life of the entire plant was eventually destroyed. Between these two extremes were plants in all stages of disease, but very few of them had any market value.

Results.—The results of the season's experiments may be best expressed in the following table which was prepared by actual count and weight at the end of the season, Nov. 19th, when the plants were dug. Treatment was begun July 30th and continued until cool weather appeared about September 15th.

FIG. VIII.—One of the best plants from a control plat.

TABLE.

No. of plat.	Kind and nature of treatment.	Original number of plants in plats.	No. of plants that survived through out the season.	Total wgt. of plants at end of season.	Average wgt. of individual plant.
No. 1	Shaded from July 30 to Sept. 15.	100	75	2 lbs. 2 ozs.	4 and $\frac{2}{3}$ ozs.
No. 2	Control.	100	73	13 lbs. 8 ozs.	3 ozs.
No 3	Sprayed once a week with ammon. carb. copper.	100	86	28 lbs. 4 ozs.	5 and $\frac{1}{4}$ ozs.
No. 4	Control.	100	74	17 lbs. 8 ozs.	4 and $\frac{3}{5}$ ozs.
No. 5	Sprayed once a week with Bordeaux mixture.	100	96	46 lbs. 8 ozs.	7 and $\frac{3}{4}$ ozs.

FIG. IX.—One of the poorest plants from a control plat.

It is apparent from those experiments that celery blight may be readily controlled by treatment. Spraying with either Bordeaux mixture or ammoniacal carbonate of copper will entirely prevent the attacks of the celery blight fungus. It appears from the above table that Bordeaux mixture is more satisfactory than ammoniacal carbonate of copper, but previous experience as well as the experience of others shows thatammoniacal carbonate of copper (when properly made) is entirely satisfactory in keeping the plants free from blight. The treatment should be begun before the plants are attacked by the blight, hence the first spraying should be done while the plants are in the seed bed. In the above table the number as well as the weight of plants in the control plats does not represent fully their value as compared with the plants in the treated plats, since practically all the plants in the control plats were worthless while those in the treated plats were practically all of more or less value; hence the table should from a commercial standpoint show zero for the control plats as compared with the values given for the treated plats.

EXPERIENCES OF OTHERS.

One grower in 1898 who was unable to control the blight because the treatment was not begun early enough, estimated his loss at one thousand dollars. This treatment as outlined in the preceding pages if taken in time would have saved that amount to one grower in one season and it is safe to say that many others sustain losses of larger or smaller amounts each year, all of which might be saved to the growers and to Maryland, if the plants were given the proper treatment throughout the season. Some growers from central and southern Maryland who have tried spraying celery for the past two seasons write that they have been very successful in controlling the disease by the proper application of fungicides. Some have used ammoniacal carbonate of copper with entire satisfaction while others have used Bordeaux mixture with equal success. The following letter from Mr. Henry Holzapfel of Hagerstown shows how easily and completely the disease may be controlled in Western Maryland.

Prof. C. O. Townsend, College Park, Md.

My Dear Sir:—In reply to your favor I would say that in our altitude celery blight is not as difficult to control as it appears to be in our lower counties. I use but one spray, namely:—the ammoniacal carbonate of copper solution. The proportions I use are 5 ounces carbonate of copper, 2 quarts strong ammonia, 40 gallons water. We begin to spray in the seed bed when plants are yet small, and after transplanting to the field spray at least once every two weeks, until cool weather renders it unnecessary. We have no insect enemies that do any noticeable harm. Bordeaux mixture does not seem very effective in controlling the blight and is objectionable on account of the way it adheres to the plants, apparently stunting their growth. Very Respectfully,

(signed) Henry Holzapfel, Jr., Hagerstown, Md.

Although the blight is more difficult to control in our lower counties owing to the more favorable conditions for the development of the fungus, it may be controlled with equal success as in other sections by applying the fungicide more frequently.

SUMMARY.

Celery blight or rust is the only pest that is to be feared at present by growers, but this disease alone may cause complete destruction of the celery crop if no measures are taken to control it.

Celery blight may be kept under complete control by spraying either with ammoniacal carbonate of copper or with Bordeaux mixture.

The spraying should be begun while the plants are still in the seed bed, and should be continued at intervals of from one to two weeks after the plants are transplanted until the cool weather prevents the further development of the fungus. Each application of the fungicide should be thorough.

Shading will retard the progress of the disease but will not entirely prevent it from doing more or less damage.

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" " 34, July, 1895, Composition of Commercial Fertilizers sold in this State.
" " 35, Sept., 1895, Wheat, Barley, Oats and Hay Experiments.
" " 37, Feb., 1896, Composition of Commercial Fertilizers sold in this State.
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" " 39, April, 1896, Spray Calendar.
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" " 41, Sept., 1896, Test of Methods of Preparing and Feeding Corn Fodder
" " 42, Oct., 1896, The Maryland Trees and Nursery Stock Law and Other Information of Special interest to Nurserymen and Fruit growers.
" " 43, Dec., 1896, Report upon the Value of a New Corn Product.
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" " 48, June, 1897, Some Common Injurious Plant Lice with Suggestions for their Destruction.
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" " 53, March, 1898, Special Investigation of the So-called "New" Horse Disease in Maryland.
" " 54, March, 1898, Tomatoes.
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